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the central one having the highest intensity, and the tension diminishing in the successive zones surrounding the innermost, till it became inappreciable in the one most remote; the author considers this condition of the cloud to be analogous to that of the battery above described, and the phenomena of the former to receive complete illustration from the experimental results obtained with the latter.

January 20, 1848.

GEORGE RENNIE, Esq., Treasurer, in the Chair.

“On the Heat disengaged during Metallic Substitutions.” By Thomas Andrews, M.D., M.R.I.A., Vice-President of Queen’s College, Belfast, &c. Communicated by Michael Faraday, Esq., D.C.L., F.R.S. &c.

In a paper which was published in the Philosophical Transactions for 1844, the author deduced from the experimental inquiry there recorded the general law, that when one base displaces another from any of its neutral combinations with an acid, the heat evolved or abstracted is always the same, whatever that acid element may be, provided the bases are the same. Extending a similar inquiry to salts with metallic bases, he establishes, as the result of the investigation of which an account is given in the present paper, the general principle that when an equivalent of one and the same metal replaces another in a solution of any of its salts of the same order, the heat developed is, with the same metals, constantly the same, the expression “of a solution of the same order” being understood to mean a solution in which the same precipitate is produced by the addition of an alkali, or, on one view of the composition of such salts, in which the metal exists in the same state of oxidation. The metallic salts, in the precipitation of which by other metals the evolved heat was ascertained, were those of copper precipitated by zinc, iron or lead; of silver, precipitated by zinc or copper; and of lead, mercury, and platinum precipitated by zinc: and the acid elements were either the sulphuric, hydrochloric, acetic or formic acids. From the last series of experiments the author deduces, that if three metals A, B, and C, be so related that it is capable of displacing B and C from their combinations, and also B capable of displacing C, then the heat developed in the substitution of A for C will be equal to that developed in the substitution of B for C; and a similar rule may be applied to any number of metals similarly related.

January 27, 1848.

GEORGE RENNIE, Esq., Treasurer, in the Chair.

“On Galvanic Currents existing in the Blood.” By James Newton Heale, Esq., Licentiate of the Royal College of Physicians, and

Fellow of the Royal College of Surgeons of England. Communicate by P. M. Roget, M.D., Sec. R.S.

The following abstract of this paper has been drawn up by the author.

The author endeavours to prove, by inductive reasoning and by historical considerations of the earliest indication of vitality in the egg, that motion of a fluid in a certain definite circle constitutes the first link in the chain of causes by which vitality is perfected; that all the other phenomena of living structure are supplementary and superinduced upon this primary and indispensable condition; and that, although it might be possible to maintain this primary circulation under certain circumstances, even though all the other functions of life were suspended or destroyed, they, on the contrary, cannot exist independently of that circulation. He shows it to be necessary to circulation, that two fluids, or a fluid in two different states, should communicate by two points or extremities with each other, and that these extremities should present such a resistance to their mutual connexion and commixion, that the transfer of conditions of each, from one to the other, must take place, otherwise the uniformity of both would speedily put an end to the process; and it is indicated that the forces in operation in these two places would be reverse to each other; in the one it would be from arterial to venous, and in the other from venous to arterial.

The blood-vessels containing the two kinds of blood are compared by the author to two bar-magnets placed side by side, the pulmonary and systemic capillaries representing the armatures placed at their extremities; with this limitation, that as the changes in the blood take place only in the two opposed sets of capillaries, the force is necessarily generated only in them, and therefore the intermediate blood contained in the larger blood-vessels merely represents conducting wires completing the circuit. The left side of the heart is viewed as being placed in the largest ampulla of the arterial circulation, and the right side of the heart as being in the like position with respect to the venous current.

The portal circulation is alluded to, in order to prove that a propelling force is not essential to produce circulation of blood. An account is given of numerous experiments on various animals, in which the ends of two similar wires (in some cases of copper and in others of platinum) were inserted; that of the one into a vein, and that of the other into an artery, the free ends of both wires being brought into connexion with a delicate galvanometer; and it was found that during life a galvanic current was indicated, passing along the artery and returning by the vein; that this current became more feeble in proportion as the vitality of the animal declined, and again more strong as the effect of the chloroform, which was administered for the purpose of preventing pain, subsided.

The author also observed, that the strong action of a muscle (the sterno-mastoid) between the two blood-vessels tended to discharge the galvanic force as it was generated; and that when that muscle was divided, the galvanic force became much stronger. When the

connexion of the current with the lungs was severed by a ligature placed on the vein between the insertion of the wire and the heart, the current was instantly reversed, passing up the vein and returning by the artery. The same reverse current was indicated when the wires were inserted into portions of the blood-vessels which had been isolated, each by two ligatures, placed the one above and the other below the insertion of the wires. A similar effect was also obtained, as long as the blood continued to coagulate, when the two kinds of blood were drawn from the blood-vessels into separate cups, and brought into connexion with the galvanometer; the blood in the cups being connected together by the ends of a piece of copper or of a strip of muscle dipping into each.

Several experiments are related, tending to prove that the power which fluids, differing chemically from each other in however great a degree, were supposed to possess of acting chemically upon the copper wire, and thus generating currents, had been greatly exaggerated; and that much which had been attributed to this cause deserved rather to be ascribed to the polar forces, which the fluids had a tendency to assume, being discharged through the copper as a conductor, since the same effect was produced when platinum was used, and in an appreciable degree even when no metal was in contact with those artificial compounds, cotton moistened with water being only used to make the different connexions with the fluids.

The author then traces the course of the blood in the fœtus, showing that the blood passes in it, throughout the body, in the direction wholly from artery to vein; the upper half constituting one segment, and the lower half of the body the other segment of the circle; and pointed out that, thus far, there was no antagonism of forces, and therefore no power of generating a galvanic current, which he indicated was supplied by the smaller circle, through the placenta, joining the larger circle at the vena cava, and leaving it at the hypogastric arteries; the smaller circle inducing the current in the larger, in the same manner as the larger circle in the adult may be supposed to induce lesser secondary circles, as the hepatic, &c.

The author then dilates on the importance of the galvanic current in physiological and pathological inquiry; pointing out the peculiar significance of the fact of the reverse current being established as soon as the direct current is impeded; the systemic capillaries being endowed with the power of generating a force exactly the reverse to that set up in the lungs; the rapidity of the circulation thus being, *ceteris paribus*, the measure of the excess of the primary force over the resistance. He infers, that the galvanism found in the muscles owes its origin to the opposed condition of the blood in the capillary network which supplies each; the anastomoses of the arterial capillaries with each other increasing their galvanic surface, while their limited anastomoses with the veins supply the conditions necessary for the passive current. The office of conductors, for the active discharge of the accumulated force, is assigned to the nerves of the voluntary muscles; the author believing that the circuit by which this is effected is, in them, prolonged up to and from the nervous

centres; which centres are, in their turn, shown to be liberally supplied with blood-vessels capable of influencing the galvanic equilibrium. The accelerated respiration caused by increased muscular exertion is attributed to this cause. It is inferred, that the involuntary muscles are provided with apparatus within themselves, adapted to regulate their periodical galvanic discharge. The mutual reaction of distant parts is attributed to the fact of the whole body being included in one galvanic circle, which cannot be disturbed in a part without the whole participating proportionally in the effects.

February 10, 1848.

The MARQUIS OF NORTHAMPTON, President, in the Chair.

“Examination of the Proximate Principles of the Lichens.” By John Stenhouse, Esq., Ph.D.

The author, after adverting to the labours of Robiquet, Heeren, Dumas, and Kane in the investigation of the proximate principles of the lichens, especially of those which yield red colouring matter with ammonia, and also of the more recent inquirers on this subject, such as Schunck, Rochleder, Heldt and Knop, who have greatly extended our knowledge of this interesting but difficult department of organic research, proceeds to state that nearly two years ago his attention was directed by Dr. Pereira to a kind of *Orcella* weed, which had been recently imported into London from the Cape of Good Hope, but which had been rejected by the London archil manufacturers as being unfit for their use, from the small quantity of colouring matter it yields when subjected to the usual process. With a view to ascertain whether or not the red dyes obtained from the various lichens result from the action of ammonia on a certain crystalline principle, described by Schunck under the name of *lecanorine*, the author procured quantities of the several lichens usually employed by the archil makers, and subjected them to investigation; the minute details of which, together with the results, are given at length in the present paper.

The specimens examined are the following:—

I. *South American variety of Roccella tinctoria*.

The lichen was cut into small pieces and macerated with a large quantity of water for some hours, then quick-lime was added. A yellow solution was obtained, from which muriatic acid precipitated the colouring matter, as a bulky gelatinous mass; this was washed, dried on a plate of gypsum, and dissolved in hot spirits of wine (not boiling). The solution on cooling deposited the colouring principle in small white prismatic needles arranged in stars. This is—

1. *Alpha-Orsellic acid* (hydrated) $C_{32}H_{15}O_{13} + HO$
and its salt of baryta—
Alpha-Orselliate of baryta $C_{32}H_{15}O_{13} + BaO$